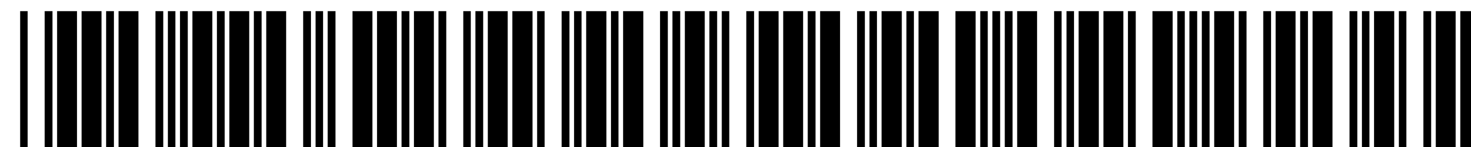

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(45) **Date of Patent: Mar. 8, 2022**

(54) **METHOD FOR FORMING A SEMICONDUCTOR PACKAGE**

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(51) **Int. Cl.**

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H05K 5/02	(2006.01)
H01L 23/053	(2006.01)
H01L 23/40	(2006.01)

(52) **U.S. Cl.**

CPC ***H05K 5/0213*** (2013.01); ***H01L 23/053*** (2013.01); ***H01L 23/40*** (2013.01); ***H01L 23/4006*** (2013.01); ***H01L 23/4093*** (2013.01); ***H05K 5/0221*** (2013.01); *H01L 2924/0002* (2013.01)

(58) **Field of Classification Search**

CPC .. H01L 23/40; H01L 23/4006; H01L 23/4093

USPC 361/717–719, 704

See application file for complete search history.

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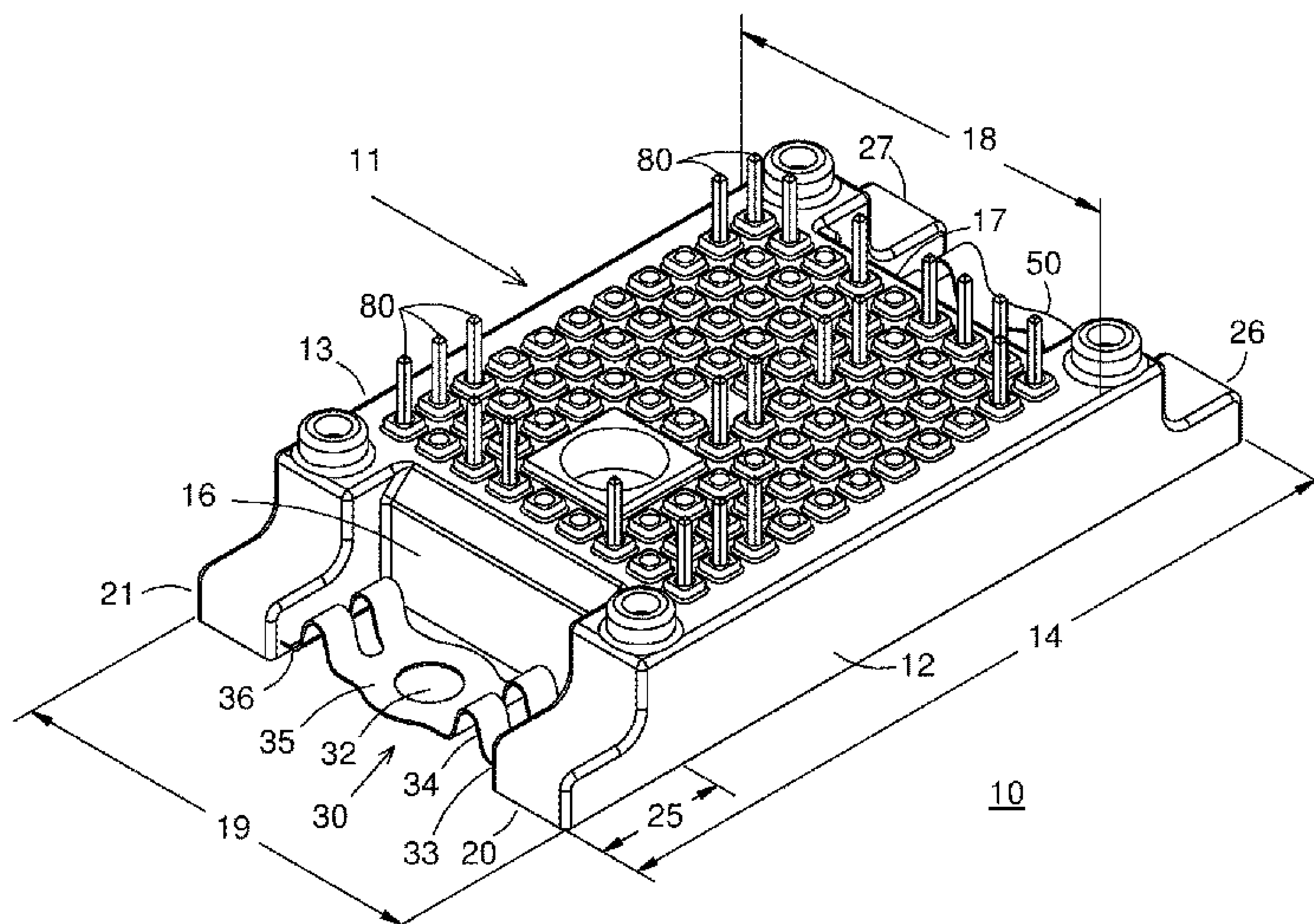
(57) **ABSTRACT**

In one embodiment, a semiconductor package may be formed having a first side and a second side that is substantially opposite to the first side. An embodiment may include forming an attachment clip extending substantially laterally between the first and second sides wherein the attachment clip is positioned near a distal end of the first and second sides. An embodiment may also include forming the attachment clip to have a flexible main portion that can bend away from a plane of the main portion toward a bottom side of the semiconductor package.

20 Claims, 6 Drawing Sheets



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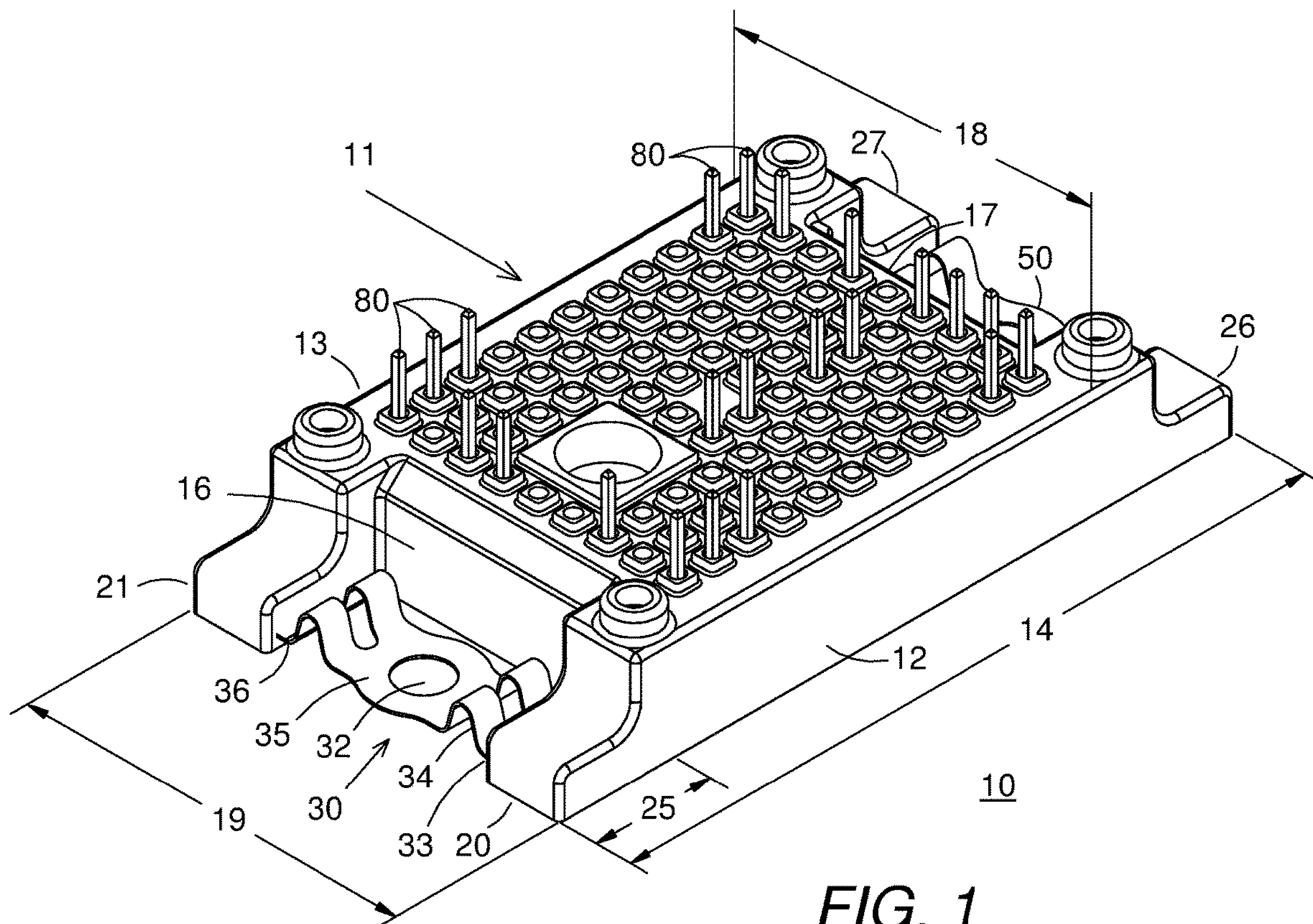

FIG. 1

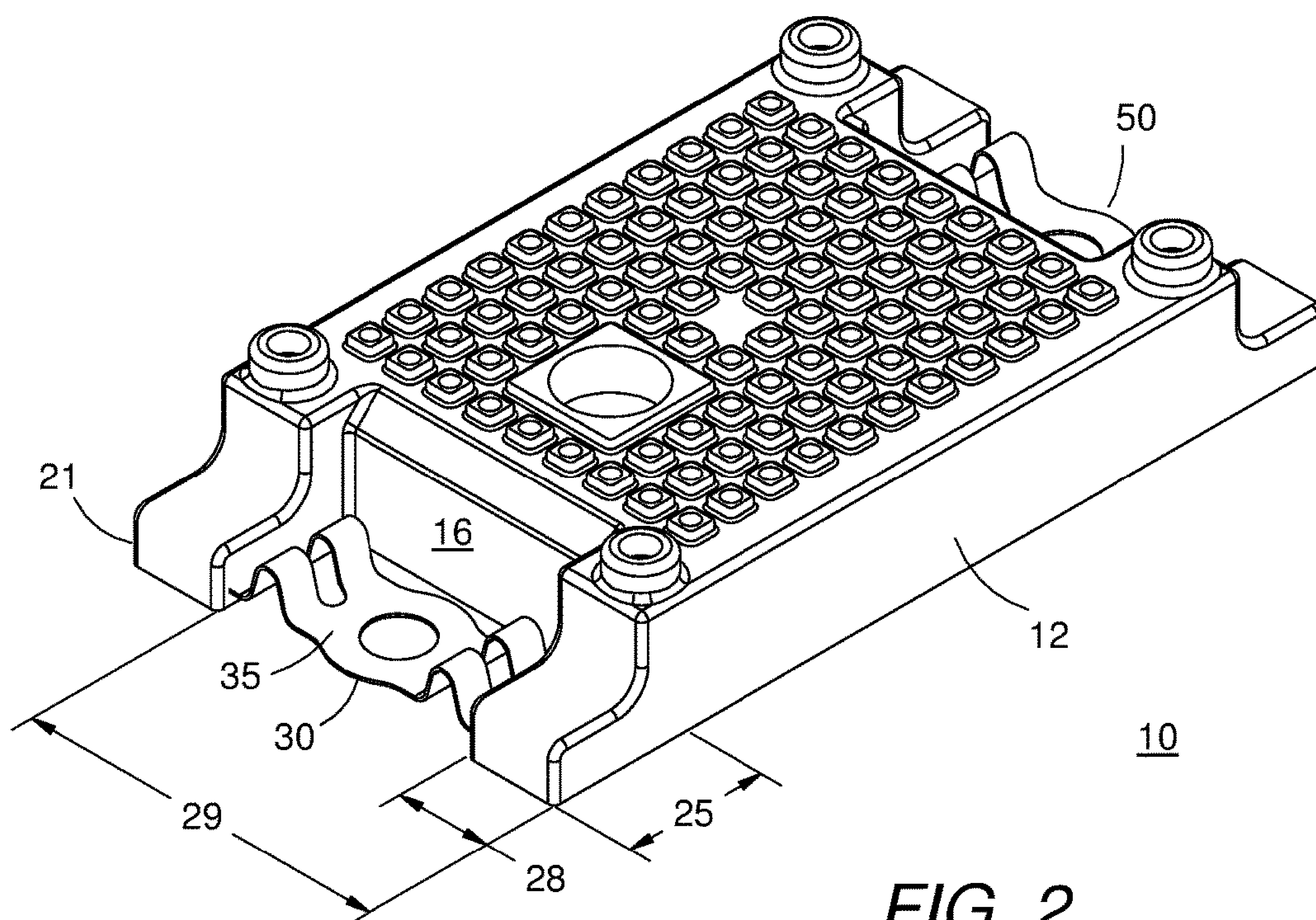

FIG. 2

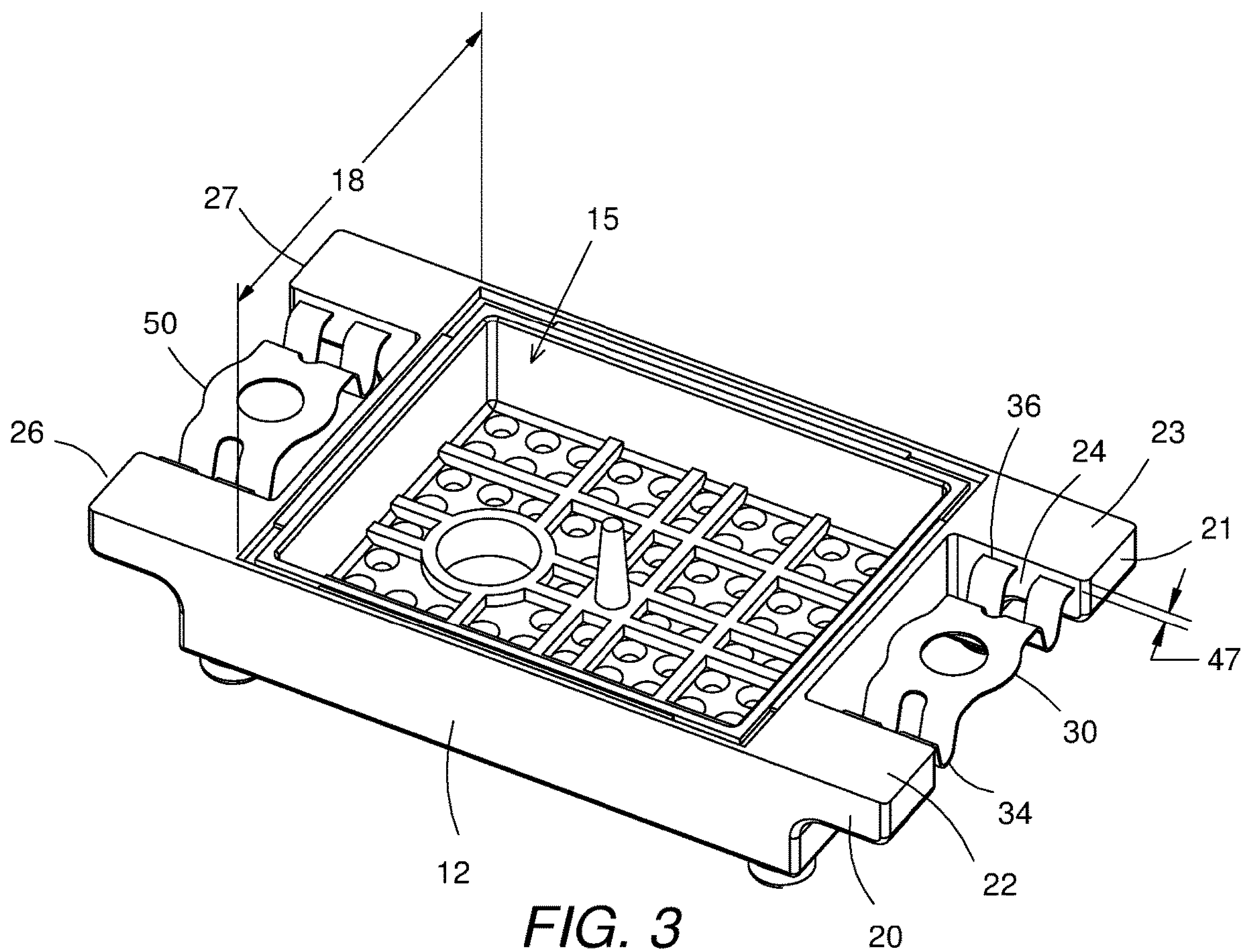

FIG. 3

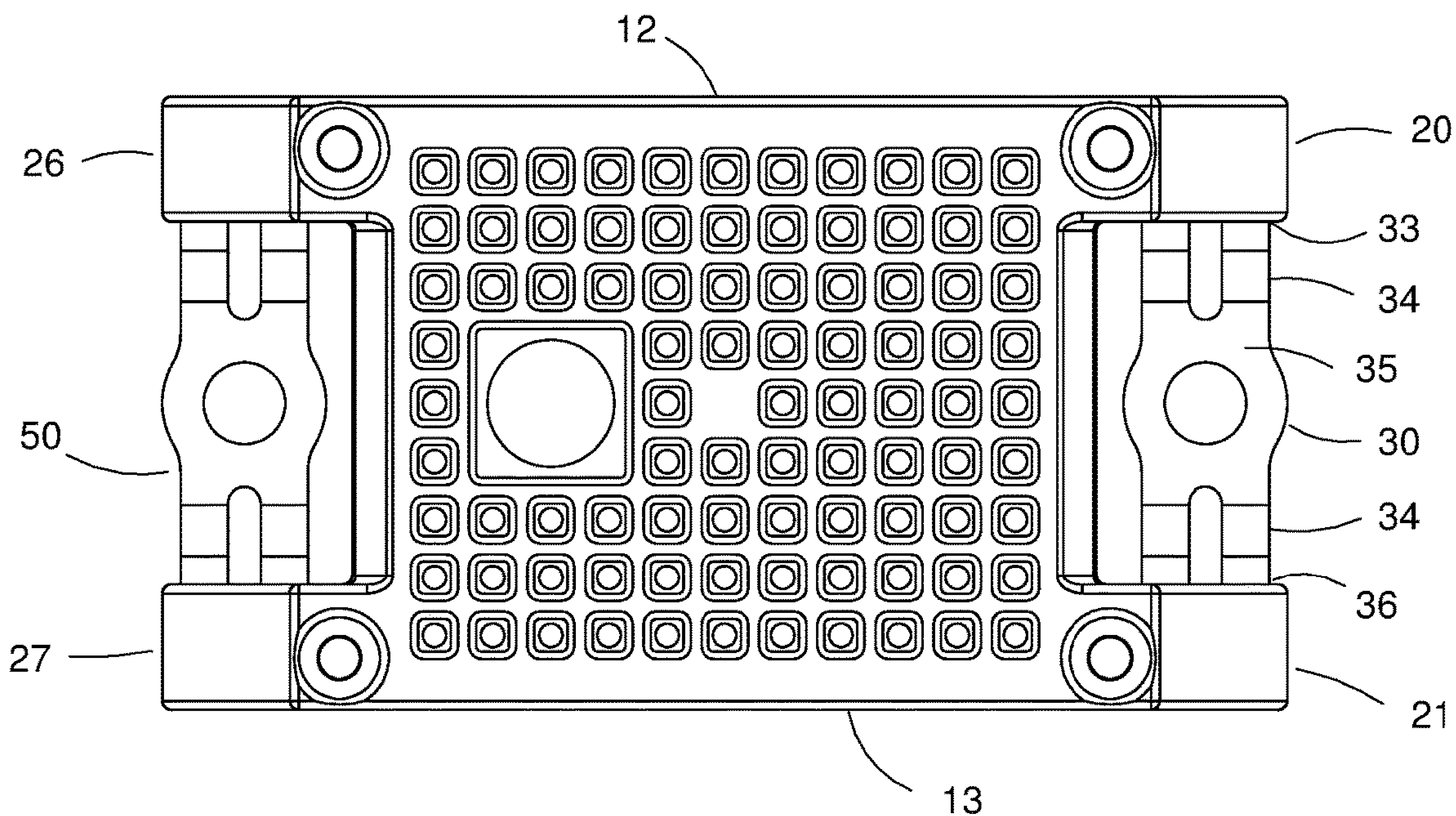

FIG. 4

FIG. 5

FIG. 6

FIG. 7

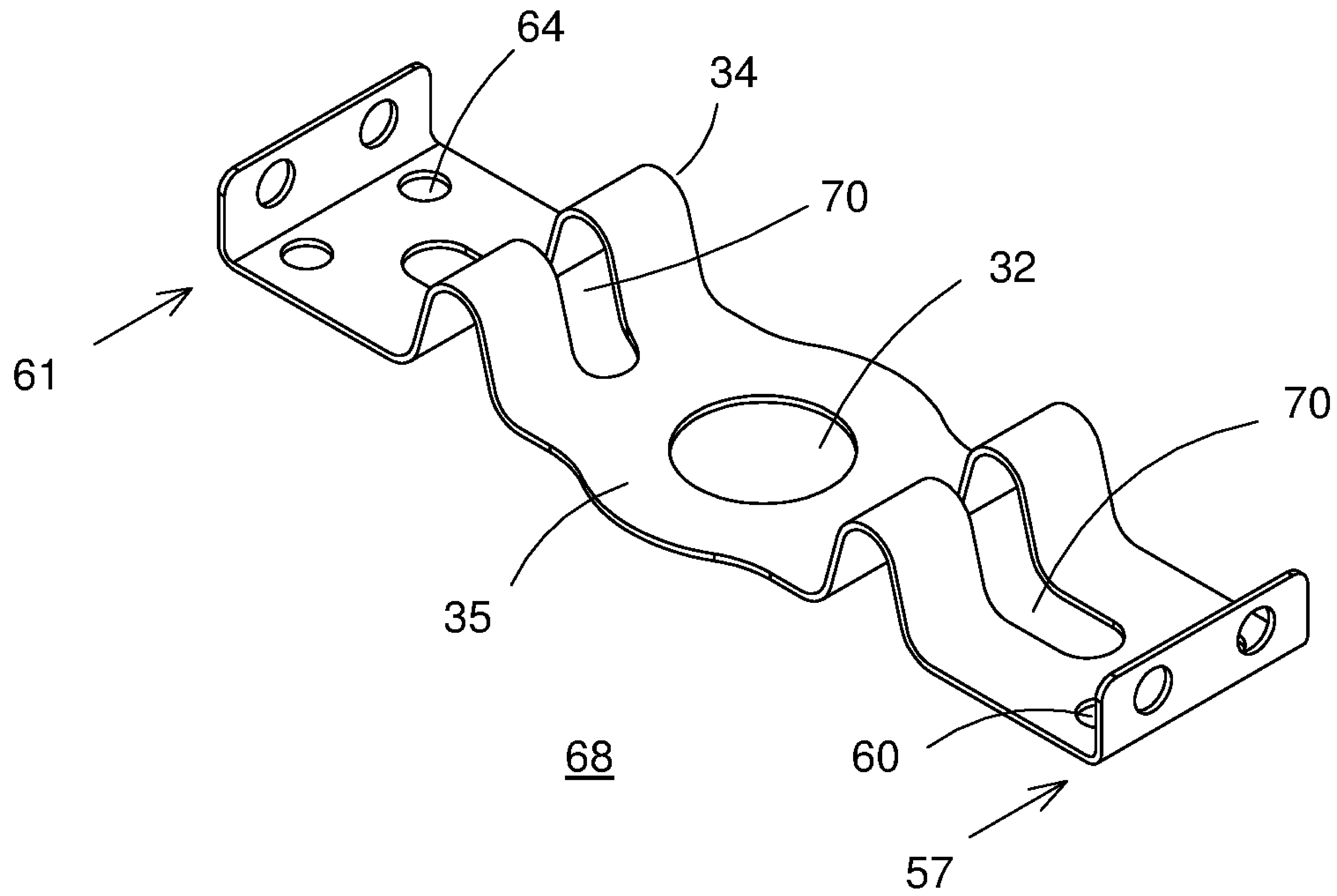

FIG. 8

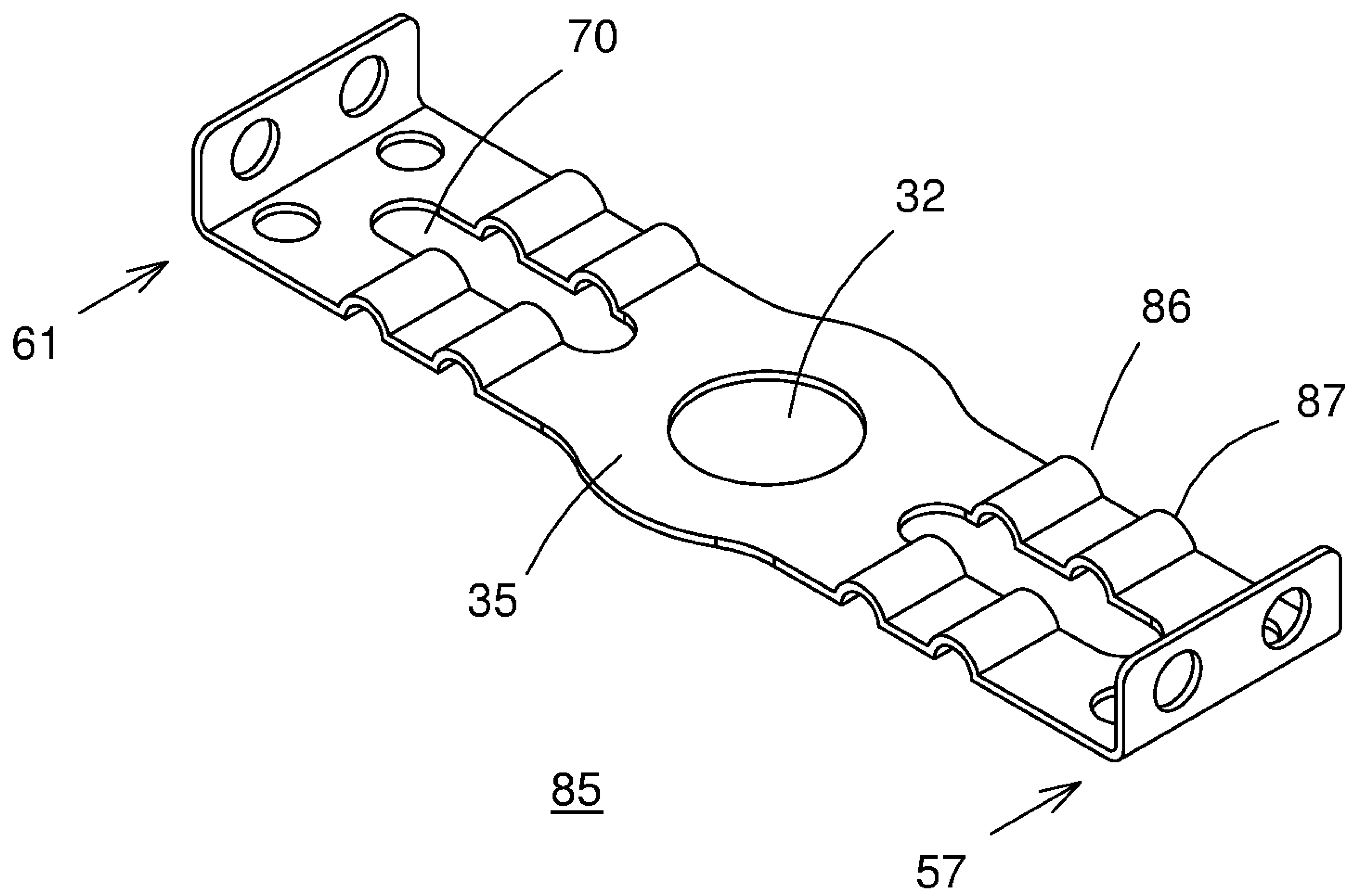

FIG. 9

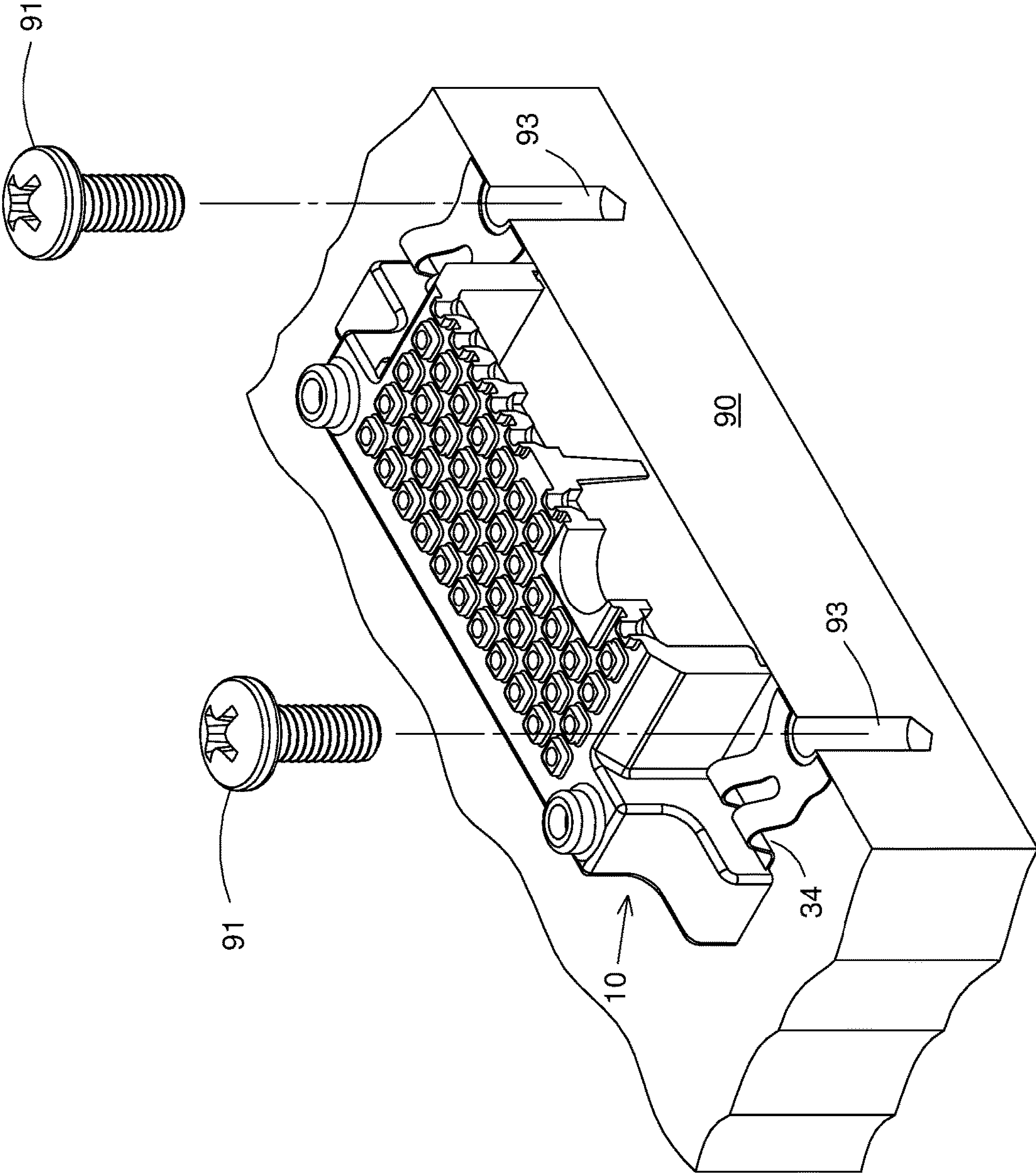

FIG. 10

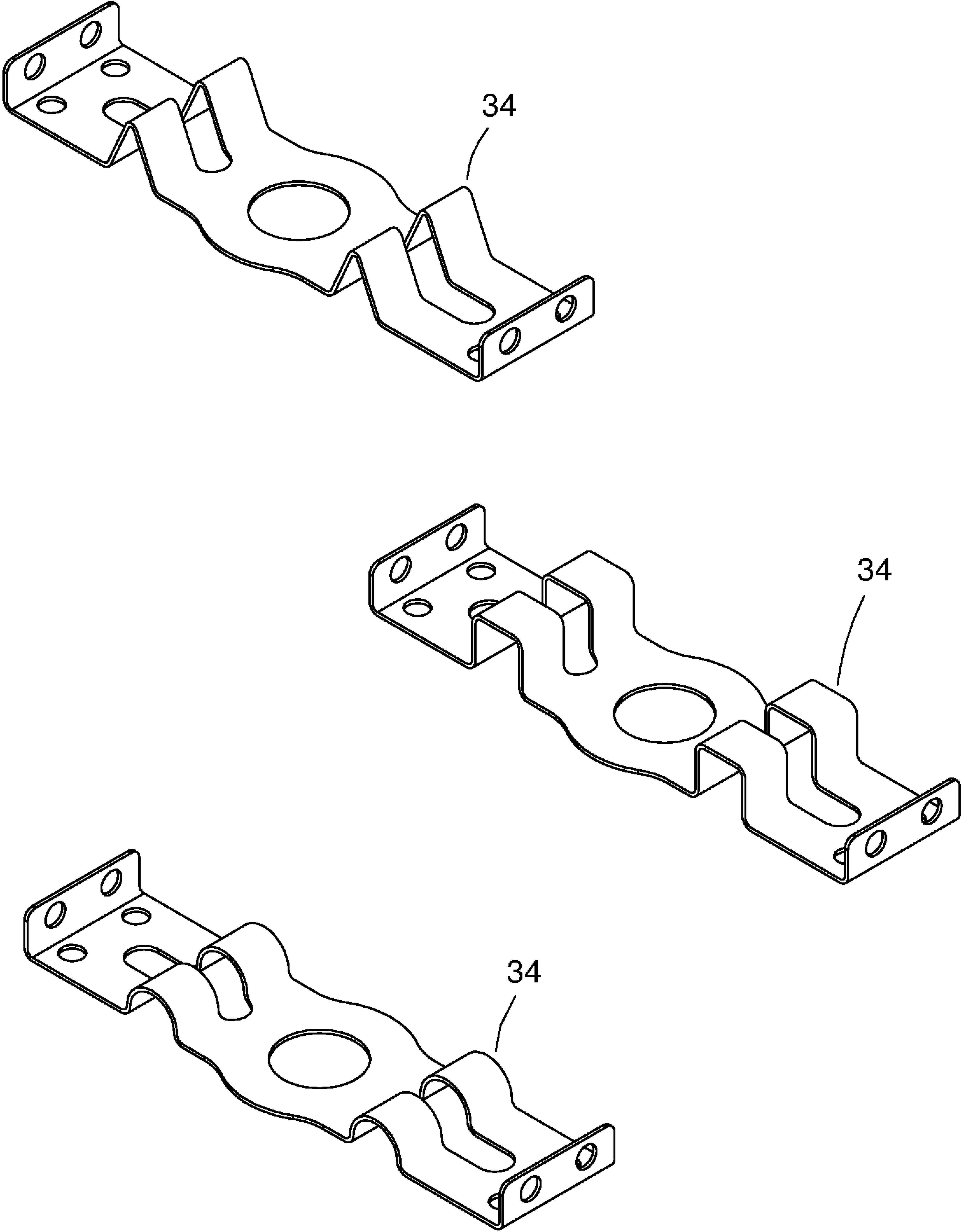

FIG. 11

METHOD FOR FORMING A SEMICONDUCTOR PACKAGE

PRIORITY CLAIM TO PRIOR PROVISIONAL FILING

This application claims priority to prior filed Provisional Application No. 61/923,156 entitled "SEMICONDUCTOR PACKAGE" filed on Jan. 2, 2014, and having common inventors Atapol Prajuckamol et al. which is hereby incorporated herein by reference. The present application is also a divisional application of prior U.S. application Ser. No. 14/568,188, filed on Dec. 12, 2014, which is hereby incorporated herein by reference, and priority thereto for common subject matter is hereby claimed.

BACKGROUND OF THE INVENTION

The present invention relates, in general, to electronics, and more particularly, to semiconductors, structures thereof, packages therefor, and methods of forming semiconductor devices.

In the past, the electronics industry utilized various methods and structures to form packages for semiconductor die or devices. Some packages were formed to accommodate several different die of various shapes. Some package types were formed to include attachment mechanisms for mechanically attaching the package to an underlying carrier such as a printed circuit board or a ceramic carrier. These carriers may or may not include a heat conducting element to which the package could be attached.

In some embodiments, the attachment mechanism did not provide a suitable contact between the package and the carrier to which the package was attached. The poor attachment could reduce heat transfer between the package and the carrier.

Accordingly, it is desirable to have a method of forming a package that facilitates an improved attachment mechanism, and/or that is configured to facilitate improved heat transfer between the package and the carrier.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates a perspective view of an example of an embodiment of a portion of a package in accordance with the present invention;

FIG. **2** illustrates a perspective view of an example of an embodiment of a portion of the package of FIG. **1** without terminals in accordance with the present invention;

FIG. **3** illustrates a perspective view of an example of an embodiment of a bottom portion of the package of FIGS. **1-2** without terminals in accordance with the present invention;

FIG. **4** illustrates a top plan view of an example of an embodiment of a portion of the package of FIGS. **1-3** without terminals in accordance with the present invention;

FIG. **5** illustrates a side elevation view of an example of an embodiment of an end portion of a portion of the package of FIGS. **1-4** without terminals in accordance with the present invention;

FIG. **6** illustrates another side elevation view of an example of an embodiment of an end portion of a portion an alternate embodiment of the package of FIGS. **1-5** in accordance with the present invention;

FIG. **7** illustrates a perspective view of an example of an embodiment of a portion of a clip that may be an alternate embodiment of a clip of the package of FIGS. **1-5** in accordance with the present invention;

FIG. **8** illustrates a perspective view of an example of an embodiment of a portion of another clip that may be an alternate embodiment of a clip of the package of FIGS. **1-5** in accordance with the present invention;

FIG. **9** illustrates a perspective view of an example of an embodiment of a portion of another clip that may be an alternate embodiment of a clip of the package of FIGS. **1-5** in accordance with the present invention;

FIG. **10** illustrates, in a general manner, a cross-section of the package of FIGS. **1-5** mounted onto an underlying carrier in accordance with the present invention; and

FIG. **11** illustrates some other examples embodiments of a loop of a clip of the package of FIGS. **1-5** in accordance with the present invention.

For simplicity and clarity of the illustration(s), elements in the figures are not necessarily to scale, some of the elements may be exaggerated for illustrative purposes, and the same reference numbers in different figures denote the same elements, unless stated otherwise. Additionally, descriptions and details of well-known steps and elements may be omitted for simplicity of the description. As used herein current carrying element or current carrying electrode means an element of a device that carries current through the device such as a source or a drain of an MOS transistor or an emitter or a collector of a bipolar transistor or a cathode or anode of a diode, and a control element or control electrode means an element of the device that controls current through the device such as a gate of an MOS transistor or a base of a bipolar transistor. Additionally, one current carrying element may carry current in one direction through a device, such as carry current entering the device, and a second current carrying element may carry current in an opposite direction through the device, such as carry current leaving the device. Although the devices may be explained herein as certain N-channel or P-channel devices, or certain N-type or P-type doped regions, a person of ordinary skill in the art will appreciate that complementary devices are also possible in accordance with the present invention. One of ordinary skill in the art understands that the conductivity type refers to the mechanism through which conduction occurs such as through conduction of holes or electrons, therefore, that conductivity type does not refer to the doping concentration but the doping type, such as P-type or N-type. It will be appreciated by those skilled in the art that the words during, while, and when as used herein relating to circuit operation are not exact terms that mean an action takes place instantly upon an initiating action but that there may be some small but reasonable delay(s), such as various propagation delays, between the reaction that is initiated by the initial action. Additionally, the term while means that a certain action occurs at least within some portion of a duration of the initiating action. The use of the word approximately or substantially means that a value of an element has a parameter that is expected to be close to a stated value or position. However, as is well known in the art there are always minor variances that prevent the values or positions from being exactly as stated. It is well established in the art that variances of up to at least ten percent (10%) are reasonable variances from the ideal goal of exactly as described. When used in reference to a state of a signal, the term "asserted" means an active state of the signal and the term "negated" means an inactive state of the signal. The actual voltage value or logic state (such as a "1" or a "0") of the signal depends on whether positive or negative logic is used. Thus, asserted can be either a high voltage or a high logic or a low voltage or low logic depending on whether positive or negative logic is used and negated may be either

a low voltage or low state or a high voltage or high logic depending on whether positive or negative logic is used. Herein, a positive logic convention is used, but those skilled in the art understand that a negative logic convention could also be used. The terms first, second, third and the like in the claims or/and in the Detailed Description of the Drawings, as used in a portion of a name of an element are used for distinguishing between similar elements and not necessarily for describing a sequence, either temporally, spatially, in ranking or in any other manner. It is to be understood that the terms so used are interchangeable under appropriate circumstances and that the embodiments described herein are capable of operation in other sequences than described or illustrated herein. Reference to "one embodiment" or "an embodiment" means that a particular feature, structure or characteristic described in connection with the embodiment is included in at least one embodiment of the present invention. Thus, appearances of the phrases "in one embodiment" or "in an embodiment" in various places throughout this specification are not necessarily all referring to the same embodiment, but in some cases it may. Furthermore, the particular features, structures or characteristics may be combined in any suitable manner, as would be apparent to one of ordinary skill in the art, in one or more embodiments.

DETAILED DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates a perspective view of an example of an embodiment of a portion of a package **10** that is configured to house a semiconductor device (not shown) that includes a semiconductor substrate. As will be seen further hereinafter, package **10** is formed to include an attachment mechanism that provides improved contact between package **10** and a carrier to which package **10** may be attached. An embodiment may include that package **10** may also be formed to provide improved thermal transfer between package **10** and the carrier. In one embodiment, package **10** may house one or more mounting substrates onto which a semiconductor device or a semiconductor substrate or a semiconductor device housed in a semiconductor package may be mounted or attached. For example, package **10** may be formed to house a polymer substrate or a ceramic substrate (not shown) having conductors on and/or in the polymer or ceramic substrate. In an embodiment, package **10** may include a case portion or case **11** having an opening or recess **15** (FIG. **3**) that is configured to house the semiconductor devices or to house the mounting substrate to which the semiconductor devices are attached. In an embodiment, case **11** and the majority of package **10** may be formed from plastic such as for example molded or formed plastic. Package **10** may also include terminals **80** that are used to form an electrical connection between elements outside of package **10** and the semiconductor devices housed within package **10**.

FIG. **2** illustrates a perspective view of an example of an embodiment of a portion of a package **10** without terminals **80**.

FIG. **3** illustrates a perspective view of an example of an embodiment of a bottom portion of a package **10** including recess **15** and without terminals **80**.

FIG. **4** illustrates a top plan view of an example of an embodiment of a portion of a package **10** without terminals **80**.

FIG. **5** illustrates a side elevation view of an example of an embodiment of an end portion of package **10** without terminals **80**. This description has references to FIGS. **1-5**.

In one embodiment, package **10** may be formed to include sides **12** and **13** that are opposite to each other and that extend along opposite sides of a length **14** of package **10**. Sides **12** and **13** typically extend parallel to each other in an embodiment. Package **10** may also include sides **16** and **17** that are positioned, respectively, at opposite ends of package **10**. Each of sides **16** and **17** may extend between sides **12** and **13** and each may have a first end that attaches to side **12** and a second end that attaches to side **13**. An end of side **12** may be formed to include a foot portion or foot or projection portion or projection **20** that extends past side **16** and an opposite end of side **12** may be formed to include another foot portion or foot or projection portion or projection **26** that extends past side **17**. Side **13** may similarly have one end that may be formed to include a foot portion or foot or projection portion or projection **21** that extends past side **16**, and an opposite end of side **13** may be formed to include a foot portion or foot or projection portion or projection **27** that extends past side **17**. Projections **20** and **26** may extend from opposite ends of side **12** past sides **16-17** and projections **21** and **27** may extend from opposite ends of side **13** past sides **16-17**. Projections **20** and **21** may be formed to extend at an angle away from side **16** and projections **26** and **27** may be formed to extend at an angle away from side **17**. In an embodiment, the angle may be substantially ninety degrees such that projections **20** and **21** extend substantially parallel to each other and substantially in the plane of respective sides **12** and **13**, and such that projections **26** and **27** extend substantially parallel to each other and substantially in the plane of respective sides **12** and **13**. In other embodiments, projections **20-21** and **26-27** may extend at different angles away from respective sides **16** and **17**. In an embodiment, projection **20** extends a distance **25** from the plane of side **16**. Projections **21**, **26**, and **27** may extend similar distances from the plane of the corresponding sides. In other embodiments, the projections may extend different distances from the plane of sides **16** and **17**. An embodiment may include that case **11** is formed to have a width **18** that is substantially constant along length **14**. In an embodiment, package **10** may be formed to have width **18** substantially constant along length **14**. Thus, projections **20-21** and projections **26-27** would have a width between the outside edges of projections **20-21** and between the outside edges of projections **26-27** that is substantially width **18**. In other embodiment, projections **20-12** and/or projections **26-27** may have widths that are different from width **18**. An embodiment may include that projection **20** is formed to have a thickness or width **28** along the plane of side **16**. In an embodiment, projections **21**, **26**, and **27** may be formed to have width **28**, or alternately may have other widths in other embodiments. Width **28** may be greater than the width of sides **12** and **13** along the portion of sides **12** and **13** in case **11**, in an embodiment. An interior distance **29** between the interior edges or interior sides **48** and **24** (FIG. **5**), respectively, of projections **20** and **21** typically is formed to be less than width **18**. In other embodiments, distance **29** may be greater than or may be equal to width **18**. For example, projections **20** and **21** may extend away from side **16** at an angle that causes a distance **19** between the outside edges of projections **20-21** to be greater than width **18**. In most embodiments, width **19** may be substantially the same as width **18**.

Package **10** may be formed to include an attachment clip or clip **30** and an attachment clip or clip **50** that facilitate attaching package **10** to an underlying carrier. One example of such a carrier and attachment is illustrated, in a general manner, in FIG. **10**. Projections **20-21** and **26-27** facilitate

attaching respective clips **30** and **50** to package **10**. In an embodiment, clip **50** may be substantially similar to clip **30** but positioned at a different location than clip **30**. This description will refer mainly to clip **30** but such references to clip **30** also include clip **50** as attached to respective projections **26-27**.

An embodiment may include that clip **30** is formed to bend without permanently deforming clip **30**. Main portion **35** may be formed to bend without permanently deforming clip **30**, in an embodiment. Clip **30** may be positioned between projections **20** and **21**. Clip **30** may be formed to extend substantially laterally between sides **12** and **13** in an embodiment, and in another embodiment may be formed to extend substantially laterally between projections **20** and **21**. In one embodiment, clip **30** has a first distal end **33** that is attached to foot **20** and a second distal end **36** that is attached to foot **21**. In an embodiment, ends **33** and **36** may be attached to respective interior sides of respective projections **20** and **21** and positioned respective distances **46** (FIG. **5**) and **47** away from respective bottom surfaces **22** and **23** of respective projections **20** and **21**. In other embodiments, ends **33** and **36** may each be positioned at a different distance from surfaces **22** and **23**. An embodiment may include that ends **33** and **36** extend past the interior sides of projections **21** and **21** and into the interior of respective projections **20** and **21**. In one embodiment, the material of projections **20-21** may be formed around ends **33** and **36** as a portion of the step of forming projections **20** and **21** or the step of forming housing **11**. For example, during the step of molding projections **20** and/or **21**.

As illustrated in general in at least FIGS. **1** and **3**, an embodiment of clip **30** may include a main portion **35** that extends between ends **33** and **36**. An opening **32** may be formed through main portion **35**. In some embodiments, opening **32** may be used to assist in attaching package **10** to the underlying carrier (FIG. **10**). In one embodiment, opening **32** may have a circular shape but may have other shapes in other embodiments. In an embodiment, opening **32** may be positioned approximately in the center of main portion **35**. Main portion **35** is not attached to side **16**, in an embodiment. In some embodiments, a section of main portion **35** may have a width near or surrounding opening **32** that is greater than a width of a section of main portion **35** that is distal from opening **32**.

An embodiment of clip **30** may be formed to include a stamping or notch or loop **34**, or a plurality of loops **34**, that may be used for either improving the strength of clip **30** or for providing some amount of spring flexibility for clip **30**. Loop **34** may be formed as a stamping or stamped portion of main portion **35** such as during the method of forming clip **30**. Loop **34** may be formed as a section of main portion **35** that extends a distance away from the plane of main portion **35**. For example, loop **34** may extend away from bottom surface **22-23** of projections **20-21**. Loop **34** may be formed in a variety of shapes including a semi-circular shape, a "V" shape, a "U" shape, or as a three sided shape such as three sides of an open parallelogram. Example illustrations of examples of some other embodiments of loop **34** are illustrated in FIG. **11**.

FIG. **10** illustrates, in a general manner, a cross-section of package **10** mounted onto an underlying carrier **90**. Carrier **90** is illustrated only as a non-limiting vehicle to assist in explaining features of clip **30** and package **10**. Carrier **90** may be a metal heat sink or a ceramic substrate that has conductors on a surface of the ceramic or a printed circuit board that has conductors on a surface or other type of carrier. An embodiment of carrier **90** may have holes **93** configured to mating accept screws **91**, such as for example as illustrated by dashed lines. Clip **30** is formed to provide a force on package **10** that firmly mates or abuts package **10** to carrier **90** or to other carriers. In an embodiment, clips **30** and **50** extend between sides **12** and **13** facilitate clips **30** and **50** applying a more uniform force along length **14** of package **10** than was formed by prior packages. In an embodiment, loops **34** may provide spring action that allows clip **30** to bend and that may also assist in forming the more uniform force. For example, as screws **91** are inserted through opening **32** and screwed down to carrier **90**, loops **34** allow clip **30** to bend as screw **91** is screwed into carrier **90**. Thus, portions of clip **30** can move downward and clip **30** can provide downward force to firmly mate or abut the underside of package **10** to the top surface of carrier **90**. Because an embodiment of clip **30** extends between sides **12** and **13**, clip **30** distributes the downward force along width **18** and length **14** to provide a more uniform downward force to all of package **10**. Those skilled in the art will understand that clip **30** can also move upwardly, such as during the removal of screw **91**.

Referring back to FIGS. **1-5** and more particularly to FIG. **5**, an embodiment of loops **34** may be formed to extend a distance **37** from the top surface of main portion **35** of clip **30**. Distance **37** is selected based on distances **46-47** from the bottom surface of projections **20-21**, and based on the amount of downward force to be applied to package **10**. In an embodiment, distance **37** may be greater than at least the thickness of clip **30**.

FIG. **6** illustrates another side elevation view of an example of an embodiment of an end portion of package **10** with clip **30** positioned at a different location of projections **20-21**. For example, clip **30** may be positioned such that the value of distances **46-47** is different. Distances **46-47** may have a variety of values. The different distances provide different spring force values. For example, in an embodiment, clip **30** may be positioned near to bottom surfaces **22-23** of respective projections **20-21**. For example, a bottom surface of clip **30** may be positioned near an intersection of an interior side **24** of projection **21** and surface **23**. An embodiment may include that the bottom surface of clip **30** may be positioned substantially parallel to the intersection of side **24** and surface **23**.

FIG. **7** illustrates a perspective view of an example of an embodiment of a portion of a clip **55** that may be an alternate embodiment of clip **30** and/or clip **50**. In an embodiment, clip **55** may be substantially the same as clips **30** or **50** except that clip **55** may have distal ends **57** and **61** that include respective bent portions **58** and **62**. In one embodiment a portion of each end **57** and **61** is bent in a plane that is different from a plane of main portion **35** or in an alternate embodiment different from a plane of the respective distal ends **57** and **61**. An embodiment may include that at least a portion of ends **57** and **61** have respective mold locks **60** and **64**. In an embodiment, a portion of bent portions **58** and **62** may have mold locks **59** and **63**, respectively. An embodiment may include that the mold locks are formed as openings in or alternately through the respective portions of clip **55**. Those skilled in the art will appreciate that clip **30** may also have mold locks (not shown) in the portions of ends **33** and **36** that are interior to projections **20** and **21**.

FIG. **8** illustrates a perspective view of an example of an embodiment of a portion of a clip **68** that may be an alternate embodiment of clips **30**, **50**, or **55**. In an embodiment, clip **68** may include an opening **70** or a plurality of openings **70** in main portion **35**. Opening or openings **70** may be formed as a slot or a plurality of slots in main portion **35**. An

embodiment may include that opening(s) **70** may be formed in loops **34**. In an embodiment, opening(s) **70** may have a length that is greater than a width of opening(s) **70**. In an embodiment, opening(s) **70** may be formed in an elongated or oval shape in a portion of main portion **35** between opening **32** and ends **57** and **61**. An embodiment of openings **70** may extend along the entire length of loop **34**. Opening(s) **70** typically do not intersect opening **32**. Opening(s) **70** may assist in providing flexibility to allow clip **68** to bend without permanently deforming clip **68**. In another embodiment, opening(s) **70** may assist in providing spring force to clip **30**. Those skilled in the art will appreciate that opening(s) **70** may be formed in any one of clips **30**, **50**, or **55**.

FIG. **9** illustrates a perspective view of an example of an embodiment of a portion of a clip **85** that may be an alternate embodiment of any one of clips **30**, **50**, **55**, and/or clip **68**. Clip **85** is substantially the same as any one of clips **30**, **50**, **55**, and/or clip **68** except that clip **85** includes a plurality of loops **86** and **87** in main portion **35** and positioned on each side of opening **32**. Those skilled in the art will appreciate that loops **86-87** may be formed in any one of clips **30**, **50**, **55**, or **68**.

From all the foregoing, one skilled in the art will appreciate that an embodiment of a semiconductor package may comprise:

a housing having a first side, such as for example side **12**;

a second side, such as for example side **13**, opposite the first side;

a third side such as for example, site **16**, extending at an angle from the first side toward the second side;

an interior portion configured for housing a semiconductor device formed on a semiconductor substrate;

a first projection, such as for example projection **20**, portion of the first side extending from the first side a first distance, such as for example distance **25**, past the third side;

a second projection, such as for example projection **21**, portion of the second side extending from the second side a second distance past the third side; and

a first attachment clip, such as for example clip **30**, having a first end attached to the first projection portion and a second end attached to the second projection portion and having a main portion, such as for example portion **35**, that extends between the first and second ends.

In an embodiment, the first attachment clip may have a loop, such as for example one of loops **34**, in the main portion.

An embodiment may include that the attachment clip may extend laterally between the first projection portion and the second projection portion.

In an embodiment, the first projection portion may have a first interior side, such as for example side **24**, oriented toward the second side and first bottom surface, such as for example bottom surface **22**, extending away from the first interior side, the second projection portion having a second interior side oriented toward the first interior side and second bottom surface, such as for example bottom surface **23**, extending away from the second interior side.

An embodiment may include that the first end of the first attachment clip may be attached a first distance, such as for example distance **46**, away from the first bottom surface and wherein the second end of the first attachment clip may be attached a second distance away, such as for example a distance **47**, from the second bottom surface.

An embodiment may include that the first distance may be substantially equal to the second distance.

In an embodiment, the first end of the first attachment clip may be attached substantially near an intersection of the first interior side and the first bottom surface and wherein the second end of the first attachment clip may be attached substantially near an intersection of the second interior side and the second bottom surface.

Another embodiment may include that the first attachment clip may have an opening, such as for example opening **32**, through the main portion.

An embodiment may include that the opening may be one of a circle or a slot extending through the main portion.

In an embodiment, the opening may be between a plurality of loops, such as for example loops **34**, in the main portion.

An embodiment of the semiconductor package may also include a fourth side, such as for example site **17**, extending at an angle from the first side toward the second side;

a third projection, such as for example projection **26**, extending from the first side a third distance past the fourth side;

a fourth projection, such as for example projection **27**, extending from the second side a fourth distance past the fourth side; and

a second attachment clip, such as for example clip **50**, having a first end attached to the third projection and a second end attached to the fourth projection and a main portion that extends between the third and fourth sides.

Another embodiment may include that the first end and the second end may have mold locks internal to the respective first and second projections.

In an embodiment, the first end may be embedded into the first projection and the second end is embedded into the second projection.

Those skilled in the art will appreciate that a method of forming a semiconductor package may comprise:

forming a first side, such as for example side **12**, of the package substantially parallel to a second side, such as for example site **13**, of the package;

forming a first attachment clip, such as for example clip **30**, extending between the first and second sides and positioned near a first end of the first and second sides wherein the first attachment clip is attached to the first and second sides;

forming a second attachment clip, such as for example clip **50**, extending between the first and second sides and positioned near an opposite end of the first and second sides wherein the second attachment clip is attached to the first and second sides;

forming a first opening through the first attachment clip and forming a second opening through the second attachment clip; and

forming a first loop in the first attachment clip and forming a second loop in the second attachment clip wherein the first loop is a portion of the first attachment clip that extends away from a plane of the first attachment clip and the second loop is a portion of the second attachment clip that extends away from a plane of the second attachment clip.

An embodiment of the method may also include forming the first loop between the first opening of the first attachment clip and a first distal end of the first attachment clip.

Another embodiment may include forming a third loop between the first opening of the first attachment clip and a second distal end of the first attachment clip.

In an embodiment, the method may include forming the second loop between the second opening of the second attachment clip and a first distal end of the second attachment clip.

Another embodiment may include forming the first attachment clip extending between a first projection, such as for example projection **20**, of the first side and a first projection, such as for example projection **21**, of the second side, and forming the second attachment clip extending between a second projection, such as for example projection **26**, of the first side and a second projection, such as for example projection **27**, of the second side.

Those skilled in the art will appreciate that a method of forming a semiconductor package may comprise:

forming a package having a first side and a second side that is substantially opposite to the first side;

forming an attachment clip extending substantially laterally between the first and second sides wherein the attachment clip is positioned near a distal end of the first and second sides;

forming the attachment clip to have a flexible main portion that can bend away from a plane of the main portion toward a bottom side of the semiconductor package.

Another embodiment of the method may include forming a loop in the main portion of the attachment clip wherein the loop is a first portion of the flexible main portion that is formed to extend away from the flexible main portion and away from the bottom of the package.

An embodiment may include forming an opening, such as for example opening **32**, in the flexible main portion and positioned with the loop, such as for example loop **34**, between the opening and a distal end, such as for example one of ends **33** or **36**, of the attachment clip.

Another embodiment may include forming an opening, such as for example opening **70**, in the loop wherein the opening has a length that is greater than a width of the opening.

In view of all of the above, it is evident that a novel device and method is disclosed. Included, among other features, is forming a semiconductor package that includes a clip configured for attaching the package to a carrier. The clip extends laterally between two adjacent sides of the package. The clip position facilitates the clip applying a downward force that assists in mating the package to the carrier. Loops may be formed in the clip to facilitate the clip bending during the attachment which may assist in forming the downward force.

While the subject matter of the descriptions are described with specific preferred embodiments and example embodiments, the foregoing drawings and descriptions thereof depict only typical and examples of embodiments of the subject matter and are not therefore to be considered to be limiting of its scope, it is evident that many alternatives and variations will be apparent to those skilled in the art.

As the claims hereinafter reflect, inventive aspects may lie in less than all features of a single foregoing disclosed embodiment. Thus, the hereinafter expressed claims are hereby expressly incorporated into this Detailed Description of the Drawings, with each claim standing on its own as a separate embodiment of an invention. Furthermore, while some embodiments described herein include some but not other features included in other embodiments, combinations of features of different embodiments are meant to be within the scope of the invention, and form different embodiments, as would be understood by those skilled in the art.

The invention claimed is:

1. A method of forming a semiconductor package comprising:

forming a first side of the package substantially parallel to a second side of the package;

forming a first attachment clip extending between the first and second sides and positioned near a first end of the first and second sides wherein the first attachment clip is attached to the first and second sides, the first attachment clip having a first opening through the first attachment clip;

forming a second attachment clip extending between the first and second sides and positioned near an opposite end of the first and second sides wherein the second attachment clip is attached to the first and second sides, the second attachment clip having a second opening through the second attachment clip; and

forming a first loop in the first attachment clip and forming a second loop in the second attachment clip wherein the first loop is a portion of the first attachment clip that extends in a first direction upward away from a plane of a central region of the first attachment clip and the portion continues to extend in a second direction back downward to substantially the plane of the central region of the first attachment clip wherein the first loop is positioned between the first opening and the first side and all of the first loop is external to both the first side and the second side, and the second loop is a portion of the second attachment clip that extends upward away from a plane of a central region of the second attachment clip and continues to extend back downward to substantially the plane of the central region of the second attachment clip wherein the second loop is positioned between the second opening and the first side and all of the second loop is external to both the first side and the second side.

2. The method of claim **1** including forming the first loop between the first opening of the first attachment clip and the first side wherein all of the first loop is external to both the first side and the second side.

3. The method of claim **2** further including forming a third loop between the first opening of the first attachment clip and a second distal end of the first attachment clip.

4. The method of claim **1** including forming the second loop between the second opening of the second attachment clip and a first distal end of the second attachment clip.

5. The method of claim **4** further including forming the first attachment clip extending between a first projection of the first side and a first projection of the second side, and forming the second attachment clip extending between a second projection of the first side and a second projection of the second side.

6. A method of forming a semiconductor package comprising:

forming a package having a first side and a second side that is substantially opposite to the first side;

forming an attachment clip extending substantially laterally between the first and second sides wherein the attachment clip is positioned near a distal end of the first and second sides;

forming the attachment clip to have a first end, a second end, and a flexible main portion that can bend away from a plane of the main portion toward a bottom side of the semiconductor package including forming material of the first side completely encasing the first end wherein the material completely covers all surfaces of the first end and wherein a portion of the material of the first side extends through an opening in the first end wherein the opening is formed to extend through a thickness of the first end, and forming material of the second side encasing the second end.

7. The method of claim **6** including forming a loop in the flexible main portion of the attachment clip wherein the loop is a first portion of the flexible main portion that is formed to extend away from the flexible main portion and away from the bottom of the package and to return to substantially the main portion.

8. The method of claim **6** including forming an opening in the loop wherein the opening has a length that is greater than a width of the opening.

9. A method of making a semiconductor package comprising:

providing a first attachment clip having a first end and a second end and a main portion that extends between the first and second ends;

forming a housing of the semiconductor package including forming a first side, a second side opposite the first side, a third side extending at an angle from the first side toward the second side, a first projection extending from the first side a first distance past the third side, and a second projection portion extending from the second side a second distance past the third side, including forming the first end and the second end of the attachment clip integrally embedded with all of the first end and all of the second end completely encased within the respective first projection and second projection during the step of forming the respective first projection and second projection integrally attached to the housing.

10. The method of claim **9** further including forming, during the step of forming the housing, a second attachment clip having a first end extending into and attached to a third projection extending from the first side of the housing, and the second attachment clip having a second end extending into and attached to a fourth projection extending from the second side of the housing, the second attachment clip having a main portion that extends between the first and second ends of the second attachment clip.

11. The method of claim **9** including forming a loop in the main portion of the first attachment clip including forming the loop as a first portion of the main portion that is formed to extend upwardly from the main portion and out of a plane of the main portion, and as a second portion that extends from the first portion back to substantially the plane of the main portion.

12. The method of **9** including forming the first projection with a first bottom surface and forming the second projection with a second bottom surface wherein the first end of the first attachment clip is attached substantially near the first bottom surface and wherein the second end of the first attachment clip is attached substantially near the second bottom surface.

13. The method of claim **9** including molding the first end and the second end of the attachment clip within the respective first projection and second projection during a step of molding the first projection and the second projection.

14. The method of claim **9** further including forming material of the first projection encasing the first end of the attachment clip and forming material of the second projection encasing the second end of the attachment clip.

15. The method of claim **9** wherein providing the first attachment clip includes providing the first attachment clip having a first loop having a first loop portion extending upward from a plane of the main portion wherein the first loop portion is positioned between a center of the main portion and one of the first projection or the second projection.

16. The method of claim **15** including providing the first loop having a second loop portion extending upward from distal to the central region of the main portion and out of a plane of the main portion toward and intersecting with the first loop portion.

17. The method of claim **15** including providing a second loop portion of the first loop that extends from the first loop portion back to the main portion.

18. The method of claim **9** wherein forming the housing of the semiconductor package includes forming the first end of the first attachment clip a first distance away from a first bottom surface of the first projection and forming the second end of the first attachment clip a second distance away from a second bottom surface of the second projection.

19. The method of claim **18** including forming the first distance substantially equal to the second distance.

20. The method of claim **18** including forming the first distance and the second distance to be substantially equal and approximately in a plane of the first bottom surface.

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